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RESEARCH REPORT

Assessing Digital Information Literacy in Higher Education: A Review of Existing Frameworks and Assessments With Recommendations for Next-Generation Assessment

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Digital information literacy (DIL) — generally defined as the ability to obtain, understand, evaluate, and use information in a variety of digital technology contexts — is a critically important skill deemed necessary for success in higher education as well as in the global networked economy. To determine whether college graduates possess the requisite knowledge and skills in DIL, higher education institutions must be able to administer and use results from valid assessments of DIL. In this paper, we provide a comprehensive review of existing definitions of this construct in major frameworks from higher education and the workforce and propose an operational definition of DIL. Next, we provide a review of existing assessments of information literacy and related constructs, including features of the assessments, construct alignment, and psychometric properties (i.e., reliability and validity evidence). Finally, we discuss challenges and considerations surrounding the design, implementation, and use of next-generation assessments of DIL. We offer this review as a resource for higher education institutions in selecting among existing assessments or in designing their own measures.

Keywords Digital information literacy; information literacy; information problem solving; higher education; assessment; student learning outcomes

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Today's information environment is constantly evolving as new technologies are developed and adopted by greater numbers of individuals. Adding to the complexity of this environment is the exponential growth in the volume of digital information being produced (Gantz & Reinsel, 2012; School of Information Management and Systems, University of California – Berkeley, 2003; SINTEF, 2013). IDC, a company that has been tracking and analyzing the growth of digital data since 2005, has estimated that from 2012 until 2020 the size of the digital universe will effectively double every 2 years (Gantz & Reinsel, 2012). SINTEF (2013), an independent research organization, added that 90% of all the world's data, which includes commercial and crowd-sourced images, videos, e-mail, voice mail, and texting, has been generated over the past 2 years. Because widely available mobile devices allow consistent and continual access to information networks (Pew Research Center, 2015) with a few taps of a smartphone, tablet, or other device, users can share text, images, and video data with relative ease from across the globe. The unprecedented growth in digital information and proliferation of related information and communication technologies (ICT) has impacted every aspect of our personal and professional lives (Organisation for Economic Cooperation and Development [OECD], 2013b; United Nations Educational, Scientific, Cultural Organization [UNESCO], n.d.). The way we live and work has changed dramatically due to the escalating scope and complexity of the digital information landscape, and so has the set of skills needed to fully participate in and benefit from an economy based on digital information creation and communication.

Employees must be able to effectively locate, evaluate, and use information to carry out workplace responsibilities (Bruce, 1999; Cheuk, 2002). Uses of information and related technologies can range from collaborating with colleagues to intellectually manipulating information for problem-solving and decision-making and communicating those findings to customers (Bruce, 1999). Cheuk (2002) described in a UNESCO white paper how a lack of these skills can have a deleterious effect on businesses. According to the report, employees need to create, access, organize, use, evaluate, package, and present information for various purposes at work, yet inefficiencies in these processes, partly due to employees' lack of pertinent skills, are often costly. For example, in one study, employees reported that they do not know what resources are available to them and therefore waste valuable time looking at information from

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inappropriate sources, which may also compromise the quality of their work (Cheuk, 2002). Similarly, De Saulles (2007) attributed loss of business income in the United Kingdom to inefficient searching for information. Others have reported that many workforce employees lack the skills to use information effectively (Head, 2012; Raish & Rimland, 2016; Thompson, 2003).

Not only does the inability to use information effectively cost businesses billions of dollars, but it also may be associated with a lower quality of life. UNESCO (n.d.) claimed that competency in media and information skills is necessary for life and work today. The OECD (2013a) added that proficiency in problem-solving in technology-rich environments (defined as the ability to use digital technology "to acquire and evaluate information, communicate with others, and perform practical tasks" [Programme for the International Assessment of Adult Competencies [PIAAC] Expert Group in Problem Solving in Technology-Rich Environments [PS-TRE], 2009]), traditional literacy, and numeracy are key skills needed for 21st century economies. Results of PIAAC, which was administered to approximately 166,000 adults from 24 countries, suggest that people with low proficiency in solving problems in digital contexts face a much greater risk of economic disadvantage and a higher likelihood of unemployment and poor health (OECD, 2013a).

The lack of information skills proficiency is an overarching societal concern, in terms of impact on both personal and professional life. In particular, employers are concerned about the proficiency levels of new entrants into the workplace. When 318 employers were surveyed about the preparation of recent college graduates for the workforce, 72% of respondents indicated that educational institutions should place greater emphasis on the ability to locate, organize, and evaluate information from multiple sources as a higher education learning outcome (Hart Research Associates, 2013). Similarly, qualitative interviews with 23 US employers (representing almost 500,000 employees in total) conducted in 2012 revealed that the employers generally perceived recent graduates as being technology savvy but were dismayed by the employees' limited ability to locate information to solve workplace problems (Head, 2012). There thus appears to be a disjunction between perceptions of fluency with digital technology and effectiveness of actual use.

Reports from employers, combined with focus group studies in which recent college graduates reported that they feel unprepared to solve information problems in the workplace (Head, 2012), have influenced the higher education community, including professional associations and regional accrediting bodies alike, to identify effective information skills as a core learning outcome. For example, the American Association for Higher Education and the Council of Independent Colleges endorsed the *Information Literacy Competency Standards for Higher Education* (IL standards; Association of College and Research Libraries [ACRL], 2000), and the Council for the Accreditation of Educator Preparation's (CAEP; 2013) *Accreditation Standards* has acknowledged technology and digital learning as a learning theme that pervades all content areas. Similarly, a number of regional accrediting bodies have identified expectations for effective information use (Saunders, 2007), including the Western Association of Schools and Colleges (WASC) Senior College and University Commission (2013), which has incorporated information literacy as one of five core competencies. The higher education community has acknowledged that the ability to use information effectively is fundamental to success in a rapidly changing technology- and information-intensive society, in turn creating the need to establish baseline skill levels and assess student learning related to these outcomes. This need to assess digital information literacy (DIL) skills requires valid measures that meet the needs of higher education institutions.

In the current paper, we investigate the construct of DIL, both from the perspective of possible definitions as well as through a review of available assessments of information literacy skills. Our purpose is to assist institutions in thinking through the various assessment and measurement issues associated with evaluating the DIL skills of their students, such as for the purposes of accreditation or curricular improvement. First, we describe various definitions of DIL and related constructs put forward in the literature by higher education, workforce, and other organizations, including areas of commonality and discrepancy among these definitions. From this synthesis, we present a proposed operational definition of DIL that can be used to support the design of assessments of DIL competency. We then review several existing assessments of DIL with respect to the assessment purpose, coverage of the construct, and item formats. We also include discussions of the reliability and validity evidence associated with each assessment, where available. Following this review, we discuss the challenges associated with designing DIL assessment. Finally, we present recommendations for assessment design features that can be used to support the development of assessments of DIL as a student learning outcome (SLO) for higher education. The review of current assessments and the proposed definition and assessment design presented here are intended to support higher education institutions in either developing their own local assessments or choosing among available alternatives when deciding to evaluate the DIL skills of their students.

Review of Frameworks of Digital Information Literacy

Definitions of Digital Information Literacy in Key Frameworks

DIL involves obtaining, understanding, evaluating, and using information in a variety of digital technology contexts. Extending beyond traditional definitions of "mere literacy" (cf. New London Group, 1996, p. 64) as a set of linguistic skills enabling reading (i.e., decoding and comprehension) and writing (i.e., transcription, composition) to build knowledge and communicate with others, DIL encompasses the knowledge and skills required for critically and effectively using digital information to achieve personal, civic, or workplace goals. However, definitions of this construct vary depending on the extent to which they emphasize particular dimensions of proficiency within DIL, such as a focus on use of specific technologies (e.g., use of e-mail or web browsers) versus the ability to critically evaluate and apply specific information content to answer questions or solve problems. For the purposes of designing an assessment of DIL as an SLO, examining the points of consistency and discrepancy among the definitions or frameworks for DIL helps ensure that the assessment will provide evidence of valued aspects of the construct (i.e., construct validity). Table 1 presents definitions of DIL drawn from frameworks developed at state, national, and international levels. These frameworks serve as a basis for our proposed operational definition of DIL to inform a DIL assessment that serves the needs of higher education institutions.

Dimensions of Digital Information Literacy

A review of the definitions presented in Table 1 indicates a great deal of similarity among the conceptions of DIL available in the existing literature, although some definitions emphasize certain aspects of the construct. Table 2 displays the correspondence between the frameworks reviewed and key dimensions of the DIL construct apparent in those frameworks. Across the definitions in the frameworks, the components of DIL include the use of digital technologies in the service of defining information needs; accessing, evaluating, and managing or organizing sources; integrating or synthesizing information from multiple sources; creating and communicating information to audiences; using or applying information to solve problems; and understanding of ethical and legal issues surrounding information use. These components appear as columns in Table 2.

Of these dimensions, accessing, evaluating, and managing information were explicitly included in all or nearly all frameworks reviewed (and some frameworks refer to organization or management but consider it a subcomponent of another skill; e.g., International Society for Technology in Education [ISTE], 2007). Communication, application to problem-solving, and ethical considerations were also quite common, although some frameworks only indirectly refer to communication or information use (e.g., the PIAAC PS-TRE framework emphasizes problem-solving but does not include ethical or legal use of information; PIAAC Expert Group in PS-TRE, 2009). Defining and refining information needs, integrating information from multiple sources, and creating digital media products were mentioned as part of the construct, though with somewhat less consistency than other aspects. For example, only five frameworks explicitly refer to integration and synthesis skills, though four allude to these components in the context of applying information to solve problems. Interestingly, despite the fundamental integration of information and communication technology embedded in the notion of DIL, frameworks varied in the extent to which they explicitly included the use of digital technology tools and applications in their definition of the construct.

In sum, DIL involves a variety of goal-driven interactions with information sources and products in digital contexts, including the ability to define and establish goals for information seeking and retrieval; successfully accessing relevant material; evaluating retrieved sources for their quality and reliability; organizing the information contained in those sources according to a scheme that suits one's purposes; making sense of varied and potentially conflicting information by integrating across multiple sources; and using that integrated understanding to answer questions, solve problems, or create digital media products that make effective use of information. From this summary, we propose an operational definition of DIL, specifically intended for use in supporting the design of assessments of DIL as an SLO in higher education contexts.

Proposed Digital Information Literacy Operational Definition

Based on the previous synthesis of existing definitions of DIL, we propose to define DIL as the ability to function in a knowledge society through the appropriate use of information and communication technology to solve information

Table 1 Existing Definitions of Digital Information Literacy (or Equivalent) Construct

Framework	Author/sponsor	Digital information literacy (or equivalent) definition
Information Literacy Competency Standards for Higher Education	Association of College and Research Libraries (ACRL)	The information literate student: *determines* the nature and extent of the information needed; *accesses* needed information effectively and efficiently; *evaluates* information and its sources critically and incorporates selected information into his or her knowledge base and value system; individually or as a member of a group, *uses* information effectively to accomplish a specific purpose; and *understands many of the economic, legal, and social issues* surrounding the use of information and accesses and uses information ethically and legally (ACRL, 2000, pp. 2–3)
Framework for Information Literacy for Higher Education	Association of College and Research Libraries (ACRL)	Information literacy is the set of integrated abilities encompassing the reflective discovery of information, the understanding of how information is produced and valued, and the use of information in creating new knowledge and participating ethically in communities of learning (ACRL, 2015). Information literacy involves six ‘threshold concepts’ (foundational concepts that create new perspectives and ways of understanding a discipline or knowledge domain): *authority is constructed and contextual*, *information creation as a process*, *information has value*, *research as inquiry*, *scholarship as conversation,* and *searching as strategic exploration* (ACRL, 2015).
LEAP VALUE Rubric for Information Literacy	Association of American Colleges & Universities (AACU)	Information literacy is defined as “The ability to know when there is a need for information, to be able to identify, locate, evaluate, and effectively and responsibly use and share that information for the problem at hand.—Adopted from the National Forum on Information Literacy” (Rhodes, 2010). The information literate person can: *determine the extent of information needed*, *access the needed information*, *evaluate information and its sources critically, use information effectively to accomplish a specific purpose*, and *access and use information ethically and legally* (Rhodes, 2010).
California ICT Digital Literacy Policy Framework	California Emerging Technology Fund (CETF)	“ICT literacy is using digital technology, communications tools and/or networks to access, manage, integrate, evaluate, create and communicate information in order to function in a knowledge society” (CETF, 2008, p. 5). The basic elements of digital literacy include *accessing* (knowing about and knowing how to collect and/or retrieve information), *managing* (applying an existing organizational or classification scheme), *integrating* (interpreting and representing information—summarizing, comparing, and contrasting), *evaluating* (making judgments about the quality, relevance, usefulness, or efficiency of information), *creating* (generating information by adapting, applying, designing, inventing, or authoring information), and *communicating* (communicating information persuasively to meet needs of various audiences through use of an appropriate medium (CETF, 2008, p. 5).
Assessment & Teaching of 21st Century Skills (ATC21S)	Collaboration among Cisco, Intel, and Microsoft	*Tools for Working—Information Literacy* *Knowledge:* Access information efficiently and effectively, and evaluate it competently; use and manage information; apply technology effectively. *Skills:* Access and evaluate information, including ability to search, collect, and process electronic information; use and manage information across multiple formats and document types, in various contexts. A*ttitudes/Values/ Ethics:* Propensity to use information critically and reflectively while working alone or in teams; Using information responsibly while respecting privacy, cultural, and community differences (Binkley et al., 2012, p. 40).
ICT Literacy Definition and Proficiency Model	Educational Testing Service (ETS) and International ICT Literacy Panel	*ICT Literacy* “is the ability to appropriately use digital technology, communication tools, and /or networks to solve information problems in order to function in an information society. This includes the ability to use technology as a tool to research, organize, and communicate information and having a fundamental understanding of the ethical/legal issues surrounding accessing and using information” (Katz et al., 2004, p. 7). The proficiency model of ICT literacy includes the following dimensions: *define* and represent information needs, *access* information sources*, evaluate* sources for their quality (relevance and reliability)*, manage* and organize information*, integrate* and synthesize information across sources*, create* or adapt information in digital environments, and *communicate* information appropriately given specific purposes, venues, and audiences (Katz et al., 2004). See also International ICT Literacy Panel (2002).
Australian and New Zealand Information Literacy Framework	Australian and New Zealand Institute for Information Literacy (ANZIIL)	Information literacy is defined as “an understanding and set of abilities enabling individuals to ‘recognise when information is needed and have the capacity to locate, evaluate, and use effectively the needed information’” (Bundy, 2004, p. 3). The information literate person: *recognises the need for information* and determines the nature and extent of information needed; *finds needed information* effectively and efficiently; *critically evaluates information* and the information seeking process; *manages information* collected or generated; *applies prior and new information* to construct new concepts or create new understandings; *uses information with understanding* and acknowledges cultural, ethical, economic, legal, and social issues surrounding the use of information (Bundy, 2004, p. 11).

Table 1 Continued

Framework	Author/sponsor	Digital information literacy (or equivalent) definition
PIAAC Problem Solving in Technology-Rich Environments (PS-TRE), subscale of Survey of Adult Skills	Organisation for Economic Cooperation and Development (OECD)	"Problem solving in technology-rich environments involves using digital technology, communication tools and networks to acquire and evaluate information, communicate with others and perform practical tasks . . . . focus[ing] on the abilities to solve problems for personal, work and civic purposes by setting up appropriate goals and plans, accessing and making use of information through computers and computer networks" (PIAAC Expert Group in PS-TRE, 2009, p. 9). Construct includes Cognitive, Task, and Technological dimensions. Cognitive dimensions of the construct include *goal setting and progress monitoring*, identifying needs, establishing and applying criteria, monitoring progress; *planning and self organizing*, using plans, procedures, strategies, and choosing appropriate tools or methods; *acquiring and evaluating information*, attending, selecting, judging reliability, relevance, comprehensibility, and reasoning about sources and contents; *making use of information*, organizing, integrating, and making decisions from working with multiple texts, transforming information across formats, and communicating with relevant parties (PIAAC Expert Group in PS-TRE, 2009, p. 12). The construct includes information processing skills such as evaluating and integrating information across multiple sources (OECD, 2013c).
Global Media and Information Literacy (MIL) Assessment Framework	United Nations Educational, Scientific, and Cultural Organization (UNESCO)	*Media and Information Literacy* "MIL is defined as a set of competencies that empowers citizens to access, retrieve, understand, evaluate and use, create, as well as share information and media content in all formats, using various tools, in a critical, ethical and effective way, in order to participate and engage in personal, professional and societal activities" (UNESCO, 2013, p. 17). The MIL construct has three components: *access and retrieval,* recognizing the demand for, being able to search for, being able to access and retrieve information and media content*; understanding and evaluation*, understanding, assessment, and evaluation of information and media including critical analysis and organization; *creation and utilization*, the creation, utilization, communication, and monitoring of information and media content (UNESCO, 2013, p. 57).
Internet and Computing Core Certification (IC3) Global Standard	Global Digital Literacy Council (GDLC) & Certiport	*Internet and Computing Core Certification (IC3)* IC3 covers a broad range of computing knowledge and skills that proves competency in three areas: *Computing Fundamentals*, covering a foundational understanding of computing (e.g., troubleshooting, types of software applications); *Key Applications*, including popular word processing, spreadsheet, and presentation applications and the common features of all applications (e.g., file management, sorting data); and *Living Online*, covering skills for working in an Internet or networked environment, such as use of web browsers, email and other networked communication tools, and ethical use of the Internet (Certiport, n.d.).
Fluency with Information Technology (FITness) Framework	Committee on Information Technology Literacy (CITL), National Research Council	*Fluency with Information Technology* (FITness) "requires that persons understand information technology broadly enough to be able to apply it productively at work and in their everyday lives, to recognize when information technology would assist or impede the achievement of a goal, and to continually adapt to the changes in and advancement of information technology. FITness therefore requires a deeper, more essential understanding and mastery of information technology for information processing, communication, and problem solving than does computer literacy as traditionally defined" (CITL, 1999, p. 15). FITness involves three types of knowledge: *intellectual capabilities* including reasoning, managing complex problems, organizing and evaluating information, collaborating, communicating, and adapting; *fundamental concepts* including computer networks, information systems, and societal impact of information technology; and *contemporary skills* such as using an operating system or word processor, locating resources from the Internet, or communicating with others via computer (CITL, 1999, p. 4).
International Society for Technology in Education (ISTE) Standards for Students	ISTE	"The ISTE Standards-S describe the skills and knowledge [students] need to learn effectively and live productively in an increasingly global and digital society" (ISTE, 2015). The six standards include *creativity and innovation*, involving critical thinking, knowledge construction, and using technology to develop innovative processes and products; *communication and collaboration*, using media environments to communicate and work collaboratively, including at a distance; *research and information fluency*, involving use of digital tools to gather, evaluate, and use information to support inquiry; *critical thinking*, *problem solving, and decision making*, the use of critical thinking skills to plan and conduct research and to solve problems, including problem definition and data analysis; *digital citizenship*, understanding responsible and ethical use of technology and information; *technology operations and concepts*, basic understanding of how to select and make use of technology tools, including troubleshooting (ISTE, 2007).

Table 2 Alignment of Existing Frameworks With Dimensions of Digital Information Literacy

Framework	Define needs	Access	Evaluate	Manage/ organize	Integrate/ synthesize	Create	Communicate	Apply to solve problems	Ethical/ legal issues	Use of digital technologies
ACRL 2000	X	X	X	~	~		~	X	X	~
ACRL 2015	X	X	X	~	~	X	X	X	X	
LEAP	X	X	X	X	X	~	X	X	X	
CETF		X	X	X	X	X	X	~		X
ATC21S		X	X	X	X	X	~	X	X	X
ETS ICT LITERACY	X	X	X	X	X	X	X	X	X	X
ANZIIL	X	X	X	X	~	X	X	X	X	~
PIAAC PS-TRE	X	X	X	X	X		X	X		X
UNESCO MIL	X	X	X	X		X	X	X	X	~
IC3 GLOBAL		X		X		~	X		X	X
CITL FITNESS 1999	X	X	X	X		X	X	X	~	X
ISTE STANDARDS-S	X	X	X	~	~	X	X	X	X	X

Notes. X = explicitly covers this dimension of the construct; ~ = partially or indirectly covers this dimension. Blank cells indicate that the framework does not cover this dimension.

Table 3 Components of Proposed Digital Information Literacy Construct Definition

Component	Description
Define	Understand and articulate the scope of an information problem to facilitate the search for information through digital technology
Access	Collect and/or retrieve information through appropriate use of digital technology
Evaluate	Judge the extent to which digital information meets the needs of an information problem
Manage	Organize digital information to help you or others find it later
Integrate	Interpret and represent information using digital technology to synthesize, summarize, compare and contrast information from multiple sources
Create	Adapt, apply, design or construct information through digital technology

problems, including the ability to research, organize, and synthesize information through digital technology and having a fundamental understanding of the ethical/legal issues surrounding the use of such information. The proposed definition includes six components that are commonly included within existing frameworks: defining, accessing, evaluating, managing, integrating, and creating information. Each of these components is further defined in Table 3; these definitions parallel those found in the reviewed frameworks, especially California Emerging Technology Fund (CETF; 2008), the International ICT Literacy Panel (2002), and Educational Testing Service (ETS; Katz et al., 2004).

Four of the dimensions listed in Table 2 are not explicitly part of our proposed definition: communicate, apply to solve problems, ethical/legal issues, and use of digital technologies. Although we recognize the importance of communication — such as expressing the results of one's attempts to research and integrate information — through digital environments, assessments of communication skills are widely available, including through SLO assessments of writing proficiency (for a review of such offerings, see Sparks, Song, Brantley, & Liu, 2014). However, activities related to communication, such as assembling data displays or synthesizing multiple results into a conclusion, are included in the proposed definition under the categories of creating and integrating information, respectively. Similarly, application to problem-solving is encompassed under descriptions of integrating and creating information to achieve a goal.

Ethical and legal use of information, while not a major dimension of the proposed DIL construct, is involved in the processes of integrating and citing information from sources, selecting publicly available material (versus copyrighted material) for an informational display, or other tasks that involve creation or integration of information products (e.g., data displays, infographics, executive summaries). Therefore, these skills are indirectly assessed by tasks requiring students to demonstrate source selection or integration. Further, it may be easier to assess specific ethical or legal concepts through multiple-choice items rather than through performance tasks where students must demonstrate ethical behavior, an issue that we will return to in our review of existing DIL assessments and associated design considerations. Finally,

although digital tools and environments form the context for assessing DIL skills, our proposed definition does not include knowledge of, or skills in using, particular digital technology, an issue we discuss in the last section of this report.

Comparison of Proposed Definition With Existing Frameworks

Our proposed definition includes several of the most prominent aspects of appropriate retrieval and use of information in the context of digital ICT. Defining information needs is common to all information literacy focused frameworks (ACRL, 2000, 2015; Bundy, 2004; OECD, 2013b; Rhodes, 2010; UNESCO, 2013) and the *ISTE Standards for Students* (ISTE, 2007). Accessing, evaluating, and managing information are important components of both information literacy–focused and more technology-focused frameworks. Integration is most clearly mentioned by the more synthetic frameworks (i.e., frameworks that themselves were based on syntheses of multiple construct definitions; Binkley et al., 2012; CETF, 2008; PIAAC Expert Group in PS-TRE, 2009; Rhodes, 2010). Finally, creating media products by using digital technologies appears in both technology-focused and synthetic frameworks. Further, the addition of objectives related to creating information in the recent ACRL *Framework for Information Literacy for Higher Education* (IL Framework; ACRL, 2015)—and the acknowledgement of "information creation as a process" (p. 6)—marks an important distinction from the previous IL standards (ACRL, 2000), which did not explicitly emphasize information creation or the use of digital technologies per se in the creation process. In contrast to frameworks that focus on understanding and use of digital technologies themselves rather than the cognitive activities required for their use (e.g., word processing, databases, or spreadsheets; Certiport, n.d.; ISTE, 2007), the proposed DIL framework emphasizes the problem-solving and reasoning skills that occur in the context of using technology to solve information problems (cf. Katz, 2005). Thus, our proposed definition of DIL is consistent with more recent, integrative conceptions of what it means to proficiently engage with the digital information landscape in the service of solving authentic information-based problems (ACRL, 2015; OECD, 2013a; UNESCO, 2013), including task definition, retrieval, source evaluation, information management, source integration, and creation of products that represent and express the integrated knowledge and proposed solutions one has assembled.

The frameworks reviewed previously not only suggest learning outcome targets for higher education institutions, but several of them also have been used directly as the basis for the design of assessments of information literacy skill. Notably, the IL standards (ACRL, 2000) were used as the basis for the development of several assessments, including the Information Literacy Test (ILT; Madison Assessment, 2015), the Standardized Assessment of Information Literacy Skills (SAILS; Project SAILS, 2015a), and the Research Readiness Self-Assessment (RRSA; Ivanitskaya et al., 2007). The Australian Information Skills Survey (ISS; Catts, 2005) was developed to assess the six standards presented in the Australia and New Zealand Information Literacy (ANZIIL) framework. The OECD developed and administered the PS-TRE assessment based on the corresponding PIAAC framework (PIAAC Expert Group in PS-TRE, 2009); similarly, the technology-focused assessment Internet and Computing Core Certification (IC3; Certiport, n.d.) was based on the IC3 Global Standard, developed by an expert panel (Global Digital Literacy Council [GDLC]) and informed by the ISTE (2007) *Standards for Students*. The ETS definition served as the foundation for the development of the scenario-based *iSkills*™ assessment (Katz et al., 2004). The Information Literacy Assessment & Advocacy Project (ILAAP, 2015) assessment is aligned to both the IL standards (ACRL, 2000) and the newly released IL framework (ACRL, 2015). That framework is also being used to inform the design of the Threshold Achievement Test of Information Literacy (TATIL, n.d.); however, at the time of this writing, the assessment is still in development, so we exclude it from the current review.

Review of Existing Assessments of Digital Information Literacy

We now turn to a review of existing assessments of DIL (or related constructs) that might be used to evaluate the DIL proficiency of higher education students. This review is intended to illuminate the advantages and disadvantages of current approaches to assessing DIL skills, in order to inform recommendations for selecting or designing an assessment intended to provide actionable information to support program evaluation and curricular improvement, or to provide individual feedback or certification of skills. First, we describe our rationale for the choice of assessments included in this review. Then, we review key features of each assessment in terms of its format, purpose, construct coverage, and evidence of reliability and validity, where available. Detailed information about each assessment appears in Table 4.

Table 4 Existing Assessments of Digital Information Literacy

Test	Vendor	Purpose	Length	Delivery	Format	Forms & items	Scoring	Notes about task types
Information Literacy Test (ILT)	Madison Assessment	Program evaluation, student learning outcomes (SLO) assessment	60 min	Computer (online)	Multiple-choice	60-items, plus 5 pilot-test items	Automatically scored	Multiple-choice items present between three and six alternatives, and measure four of the ACRL IL standards: 1 (20%), 2 (32%), 3 (32%), and 5 (17%).
Standardized Assessment of Information Literacy Skills (SAILS)	Project SAILS/Carrick Enterprises	Program evaluation, SLO assessment	45 min individual (35 min cohort version)	Computer (web-based); paper version discontinued	Multiple-choice	Two forms: 55 items for individual and 45 items for cohort version	Automatically scored; individual version provides student scores	Students receive an overall information literacy score aligned with ACRL IL standards (regrouped into eight skill sets used for test objectives & items).
Research Readiness Self-Assessment (RRSA)	Central Michigan University	Program evaluation, diagnostic	35 min	Computer (web-based)	Multiple-choice, true/false	Two forms: 56 items for both interdisciplinary and health versions	Automatically scored and individual feedback is provided; subscores for finding and evaluating information are reported.	Items measure attitudes and skills aligned with the IL Standards (ACRL, 2000), including obtaining, evaluating, and browsing for information, understanding plagiarism and copyright issues, and self-reports of beliefs and experiences related to research.
Information Skills Survey (ISS)	Council of Australian University Librarians (CAUL)	Program evaluation	20 min	Paper	Self-report survey	Two forms: 20-item form for general social sciences and 28-item form for law	Scored by institution	Students rate their skills on a variety of information literacy activities and knowledge on a 4-point Likert scale (never, sometimes, often, always)
Information Literacy Assessment and Advocacy Project (ILAAP)	ILAAP Team/ Librarians at four Alberta institutions	Program evaluation	Varies	Computer (online)	Multiple-choice and survey items (Likert-type ratings and open-ended responses)	Institutions select from a pool of 63 multiple choice and 16 survey items	Scored by ILAAP team; aggregate reports or specific group-level reports are available.	Multiple-choice items are aligned to both IL Standards (ACRL, 2000) and revised IL Framework (ACRL, 2015). Can be used as pre- or post-test. Survey items cover demographics and perceptions of library instruction received (to be administered after a course or training session).

Table 4 Continued

Test	Vendor	Purpose	Length	Delivery	Format	Forms & items	Scoring	Notes about task types
Internet and Computing Core Certification (IC3)	Certiport	Professional certification	45 min per exam	Computer (web-based)	Multiple-choice and survey items, plus performance-based items	Three exams: 45 items per form for computing fundamentals, key applications, & living online	Automatically scored	Construct informed by earlier version of ISTE Standards, but focused on IT certification. Living online exam includes use of email, identifying sources and using a browser, and identifying ethical use of computers.
European Computer Driving Licence (ECDL)	ECDL Foundation	Professional certification	45 min per module	Computer (web-based)	Multiple-choice and performance-based items (use applications)	Thirteen modules (4 base, 5 standard, 4 advanced) with 32 items each	Automatically scored	Students can take each module as a diagnostic (practice) or certification (test) module. Students choose which modules to take. Tasks require effective use of software applications (e.g., Word processing, spreadsheets, database, and ICT). Items periodically reviewed to incorporate new technologies.
Collegiate Learning Assessment (CLA+)	Council for Aid to Education (CAE)	SLO assessment	60 min	Computer (online)	Essay (1)	Performance task	Performance task essays are automatically scored by Pearson's Intelligent Essay Assessor; three subscores reported	Performance task requires students to read a scenario, analyze and take a position or draw a conclusion about the issue described, using sources from a document library to support those claims, including citing those sources (Analysis & Problem Solving dimension)
PIAAC Problem Solving in Technology-rich Environments (PS-TRE) / Survey of Adult Skills	OECD	International benchmarking	30 min per module	Computer (web-based)	Simulation tasks with multiple-choice and performance-based items (clicking, numeric entry, highlight)	Two modules: 7 tasks in each of modules 1 & 2	Automatically scored; individual reports are not provided.	Tasks focus on the ability to analyze task requirements, define goals and plans, and monitor progress until the problem is solved, using computer-based information (e.g., in a simulated web, email, or spreadsheet environment).
iSkills	Educational Testing Service (ETS)	Program evaluation	60 min	Computer (online)	Simulation tasks with selected-response and performance-based items (use applications)	Seven tasks composed of 3–5 min interactions with simulated software	Automatically scored; individual and group reports provided.	

Table 5 Correspondence of Dimensions of Proposed Digital Information Literacy (DIL) Construct Definition With Existing Assessments of DIL and Related Constructs

	Proposed DIL construct dimensions						Other dimensions			
Assessment	Define needs	Access	Evaluate	Manage/ organize	Integrate/ synthesize	Create	Communicate	Apply to solve problems	Ethical/ legal issues	Use of digital technologies
Type 1										
ILT	X	X	X		X				X	X
SAILS	X	X	X	~					X	X
RRSA	X	X	X				~	X	X	X
ISS	X	X	X	X	X	X	X	X	X	
ILAAP	X	X	X	X	X				X	X
Type 2										
IC3		X		X		~	X		X	X
ECDL	~	X	X	X		X	X		X	X
Type 3										
CLA+			X		X	~	X	X		~
PIAAC PS-TRE	X	X	X	X	X		~	X		X
ISKILLS	X	X	X	X	X	X	X	~		X

Notes. X = assessment measures this dimension; ~ = assessment indirectly or partially claims to measure this dimension. Blank cells indicate that the assessment does not provide evidence of this dimension.

Selection of Current Assessments

For the purposes of this review, we selected assessments with a focus on higher education or adult populations, spanning various purposes (i.e., program evaluation and curricular improvement, individual certification, international benchmarking). Thus, we excluded from our review assessments of DIL competencies targeted at populations below postsecondary education, such as the Programme for International Student Assessment (PISA) Digital Reading Assessment (OECD, 2014) or the Online Research and Comprehension Assessment (ORCA; Leu et al., 2015). However, we do include the PIAAC PS-TRE component of the Survey of Adult Skills (OECD, 2013a, 2013b) because the assessment is designed to measure the information problem-solving skills of adults across a variety of authentic technological and task contexts (PIAAC Expert Group in PS-TRE, 2009). We also include professional certification tests such as the IC3 and the European Computer Driving Licence (ECDL)[1] because these assessments are used in workforce contexts to signal employers that employees have a particular level of proficiency with DIL or facility with various technological environments.

Purpose of the Assessments

The purpose of an assessment has direct implications for how the assessment is designed and administered and how the resulting scores should be interpreted and used. Although our goal is to support the development of assessments of DIL as a higher education outcome, we examined assessments designed for a variety of purposes, including program evaluation and curricular improvement (ISS, ILT, ILAAP, Collegiate Learning Assessment+ [CLA+]), individual-level certification or feedback (IC3, ECDL), assessments that provide both institutional and individual information (RRSA, SAILS, iSkills), and international benchmarking assessments (PIAAC PS-TRE). Some of the assessments (i.e., ECDL and CLA+) we included because their target constructs overlap with definitions of DIL, although they may not directly be derived from the frameworks listed in Table 1.

Broadly, these assessments fall into three categories on the basis of format and focal constructs. Table 5 presents an analysis of the correspondence between the skills targeted in each assessment (i.e., as described in construct definitions or rubric statements) and the dimensions of the proposed DIL construct definition presented previously (see Table 3). The assessments reviewed are organized by the three categories defined previously; we discuss construct coverage with respect to assessments falling within each of these categories.

Information Literacy Focus With Multiple-Choice and Constructed Response Items: Type 1 Assessments

First, we review several assessments designed to align with major frameworks for information literacy, which rely primarily on traditional item types, such as multiple-choice, true/false, or rating scales (i.e., self-report measures). This review includes four assessments directly informed by the ACRL IL standards (ACRL, 2000), namely, Madison Assessment's ILT (Wise, Cameron, Yang, & Davis, 2009), SAILS (Project SAILS, 2015a), RRSA (Ivanitskaya, 2011), and ILAAP (Goebel, Knoch, Thomson, Willson, & Sharun, 2013). Of these, the ILT has the most limited construct coverage; multiple-choice items on this assessment align with four of the IL standards (ACRL, 2000), excluding application of information to solve problems, which may be more difficult to validly assess using the multiple-choice format. It is also only intended to provide information about groups of students in the aggregate; no individual-level information is reported, so it cannot be used to provide diagnostic information or direct student feedback. In contrast, SAILS, RRSA, and ILAAP are aligned with the full span of IL standards (i.e., none are specifically excluded from the assessment scope). However, only SAILS and RRSA can provide individual-level feedback. SAILS regrouped the IL standards (ACRL, 2000) into eight skill sets that define the measurement targets in the assessment, including developing a research strategy; selecting search tools, using features of search tools, and successfully conducting searches; retrieving, evaluating, and documenting sources; and understanding economic, legal, and social issues of information use (Radcliff, Salem, O'Connor, & Gedeon, 2007). The SAILS test has two versions: a cohort version designed for program-level assessment and an individual version that provides scores directly to students. The RRSA, which measures objectives aligned with the IL Standards (ACRL, 2000) as well as students' self-reported beliefs and experiences related to information literacy, goes one step further and provides students with automated individualized feedback, including subscores for both finding and evaluating information, upon completing the test. The ILAAP (2015) is a freely available tool designed as a flexible solution for institutions to assess students' information literacy skills; institutions can select any combination of questions from a pool of both multiple-choice content questions (aligned to the IL standards and IL framework) and survey items (which primarily evaluate students' perceptions of library instruction received).

The final instrument in this category is the ISS (Catts, 2005), which is aligned to the ANZIIL framework (Bundy, 2004). The assessment items are aligned with all six of the ANZIIL framework standards, although because the items require students to provide a self-report rating (e.g., "I only list resources I have actually referred to in my assignment bibliography"; Catts, 2005, p. 13), this assessment provides a more subjective rather than objective picture of students' information literacy skills. Thus, the ISS provides group-level information on the extent to which students report engaging in a variety of skills associated with the ANZIIL framework standards (but this may over- or underestimate what surveyed students actually do in the context of solving information problems). This critique similarly applies to multiple-choice and true/false item types, which can provide valid information about students' knowledge of particular information literacy skills and concepts, but cannot provide much evidence of the extent to which students effectively deploy those skills in the various contexts of their use. As is evident in Table 5, the assessments with more traditional format and emphasis on established information literacy standards are more likely to emphasize knowledge of concepts and skills (principles for beginning research, for accessing and evaluating different kinds of information sources, or ethical and legal considerations) and less likely to emphasize reasoning and problem-solving (i.e., integration, creation, or application).

Technology Literacy Focus With Multiple-Choice and Constructed Response Items: Type 2 Assessments

A second type of assessment includes tests that primarily emphasize interaction with specific digital ICT. Two example assessments illustrate the technology-focused approach: Certiport's IC3 and the ECDL exam. Certiport's IC3 is a certification exam built on the IC3 Global Standard, a set of objectives informed by the GDLC, an international panel of experts. The ECDL is an exam given to secondary school students worldwide. Since its inception in 1996, the exam has been administered to 14 million people (ECDL Foundation, 2015a). The exam is used in a variety of ways, primarily to measure the technology literacy skills of youths over time. The ECDL Foundation is responsible for reviewing content, currency, and validity (ECDL Foundation, 2015b).

In terms of construct coverage, both of these assessments measure skill in accessing, organizing, and communicating with digital technologies, including an emphasis on ethical and legal use. For example, the base modules of ECDL include computing fundamentals (basic use of digital technologies), online essentials (encompassing accessing, evaluating, managing, communicating, and responding ethically and appropriately to information in web browsing and e-mail contexts),

word processing, and spreadsheets (creating files and media products, using features of the technology). Students can opt to take the four base modules, plus a combination of standard or advanced modules on specific applications (e.g., databases, presentation software). In contrast, the IC3 exam consists of three modules: key applications, computing fundamentals, and living online. The IC3 Living Online module overlaps the most with the DIL framework (see Table 5), including accessing, managing, and communicating via e-mail. Note that despite their use of simulated software environments, these assessments focus primarily on the use of the technology for its own sake, rather than the application of digital tools to achieve specific purposes or to solve problems.

Both assessments include multiple-choice items, interactive items (moving objects on the screen), and performance-based tasks that require the use of simulated software. Both exams are "vendor neutral," presenting simulated software that shares characteristics (menus and keyboard commands, functionality) of common software applications but are unique to the exam. These performance tasks allow for a variety of means of completing a task (e.g., printing a file); scoring is done automatically and is based on whether the candidate performed one of the allowable paths (i.e., a specific series of menu selections or keyboard presses) for the task. In fact, some items cover information literacy concepts not included in our framework, such as the ethical and legal use of information. However, the majority are technology-focused skills such as opening a file in a word processor, embedding a video in a presentation slide, navigating to a provided URL in a browser, or summing entries in a spreadsheet.

Digital Information Literacy Focus With Performance-Based Tasks: Type 3 Assessments

The third category of assessments reviewed includes those emphasizing both information literacy and technology-related skills, using more interactive, performance-based tasks as the primary format. This category includes the CLA+ (Klein, Benjamin, Shavelson, & Bolus, 2007), the PIAAC PS-TRE (OECD, 2013c), and the ETS iSkills assessment (Katz, 2007). First, we examine the CLA+, which is considered to be an assessment of higher education students' critical thinking and written communication skills (Arum & Roksa, 2011; Klein et al., 2007; Liu, Frankel, & Roohr, 2014). However, we include this assessment in our review because (a) some of the objectives of the performance assessment task overlap with identified information literacy skills (e.g., evaluating sources) and (b) this assessment has been designed and validated for use as an SLO assessment (Klein et al., 2009). Specifically, the performance tasks present students with a document library including a range of digital sources that vary in type and content (e.g., memos, newspaper articles, research reports, data tables, graphs, or e-mails). Students are expected to evaluate the credibility and usefulness of the evidence provided in the sources and to analyze, synthesize, and draw conclusions from this evidence in their response to the task (Council for Aid to Education, 2014). Because these measurement targets overlap with our proposed components of evaluation, integration, and creation of information, and because validity evidence exists for the CLA+, we maintain it as an important point of comparison in evaluating the advantages and disadvantages of particular assessment design approaches (in this case, a performance-based task with a single constructed response format item). In terms of construct coverage, this assessment explicitly covers several skills related to proficient use of information sources, including evaluation, integration and synthesis, communicating, and applying the information to solve problems. While the sources are presented in a digital format, students are not asked to make use of technology or demonstrate proficiency with ICT tools in the context of the CLA+; rather, the emphasis is on students' ability to compose a well-formed written response that includes accurate analysis of provided source materials. Thus, some inferences about students' interactions with digital information sources could be made on the basis of CLA+ results, although this is not the primary construct being measured.

In contrast to the completely open-ended approach, the iSkills and PS-TRE assessments present performance-based tasks that leverage simulated software environments, requiring test takers to interact with simulated components and select appropriate responses. For PS-TRE, items are designed according to three proficiency levels, where the highest level requires multiple steps, use of varied technologies, and deployment of higher-order cognitive processes such as monitoring and integration (OECD, 2013c). For example, one relatively simple sample item requires test takers to categorize a number of e-mail messages into folders; a more complex example might require test takers to manage a meeting room reservation system, including identifying available times that meet requester requirements, declining requests that cannot be filled, and integrating information across two simulated applications (e-mail and a web-based reservation system; OECD, 2013c). In terms of construct alignment, the PS-TRE assessment measures many critical aspects of DIL, including defining information needs, accessing, evaluating, managing, and integrating information, and most importantly for this

particular assessment, the application to problem-solving in the context of digital technology applications. The design of the PS-TRE assessment tasks is similar in some ways to the iSkills assessment developed by ETS.

The iSkills assessment is a scenario-based performance assessment of students' digital literacy skills. The assessment presents students with a series of 12 tasks, each of which consists of (a) the description of a situation in which information must be handled using digital technology and (b) simulated digital tools (e.g., word processor, presentation software) that students use in their solution to the task. The assessment system records student interactions with the simulated tools and automatically scores students' responses as well as solution process metrics that, through field studies and other empirical research, have been shown to be construct relevant. The scenarios cover a range of workplace, academic, and personal uses of information in the context of technology. Students might be asked to manage e-mails from a boss, complete work on integrating search results for a group research project from a class, or help some family members to find information about their father's high school garage band. Each realistic scenario motivates the location, use, or creation of information and introduces the simulated digital tools needed to complete the 3- to 5-minute task.

Overall, iSkills provides evidence of many key dimensions of DIL skill—including the six dimensions featured in our proposed definition of DIL (define, access, evaluate, manage, integrate, and create; see Table 3), plus an added dimension of communicating about and with digital information. The performance-based assessments reviewed previously provide richer tasks that attempt to simulate realistic contexts of information use; these assessments vary in the use of item types (i.e., open-ended constructed response vs. interactive tasks), but each achieves more direct assessment of examinee's application of DIL knowledge and skills. The extent to which this richer assessment format yields enhanced reliability and validity as compared to other assessment formats is discussed in the following section.

Reliability and Validity Evidence

A review of published reliability and validity evidence for the information literacy assessments discussed previously appears in Table 6. In the following sections, we summarize the available validity evidence with respect to reliability and various types of validity: content, construct, concurrent, and predictive validity. Note that across the assessments reviewed, the amount of available validity evidence varies considerably, and there is variation in the level of details that are reported (e.g., some reports do not include important considerations such as sample size or actual values of correlation coefficients reported to be significant). When such figures were not indicated by the study authors, we note this.

Reliability Evidence

Reliability evidence reflects the extent to which a test consistently measures the same construct. One form of evidence is internal consistency reliability, which assesses the extent to which items within a test yield consistent results. Available reliability evidence for DIL assessments appears in Table 6, Column 4. Across all assessments reviewed, the majority of reliability estimates for the total test (coefficient alpha) range from .80 to .88, thus showing good internal consistency, whether for more traditional IL measures (Cameron, Wise, & Lottridge, 2007; Catts, 2005; Clark & Catts, 2007; Ivanitskaya, 2011; Radcliff, Oakleaf, & Van Hoeck, 2015; Wise et al., 2009) or for interactive performance-based measures (Katz, 2007; Katz, Attali, & Rijmen, 2008; OECD, 2013c). Pilot test data for the technology-focused IC3 assessment also shows high internal consistency, with Kuder-Richardson-20 values ranging from .88 to .93 across administrations, and test-retest reliability (i.e., the extent to which examinee scores at Time 1 are correlated with retest scores at Time 2) was reported at .82, based on a sample of 136 retest examinees (Haber & Stoddart, n.d.). However, although the CLA+ performance tasks, which require an extended constructed response, achieves high reliability at the institution level ($\alpha = .84$; Klein et al., 2009), it is much less reliable at the individual level ($\alpha = .43$ to .57) due to the use of a single prompt for each test taker (when coupled with selected-response items, the combined reliability is comparable to other assessments, with α ranging from .85 to .87; Zahner, 2013).

The reliability of subscores was also examined. Subscores are generally less reliable than estimates for the total test, although SAILS reports that subscore reliabilities exceed .80 for all eight subdomains associated with the IL standards (ACRL, 2000), based on data from over 40,000 college students (Radcliff & Salem, 2006). For tests that report subscores associated with specific standards, subscore reliabilities (α) range from .35 to .78 for ISS (Catts, 2005), from .48 to .76 for ILT (Cameron et al., 2007; Wise et al., 2009), and from .52 to .76 for first-year college students taking RRSA (Ivanitskaya, 2011). Interestingly, when administered to a sample of master's level students, the overall test ($\alpha = .78$) and subscore

Table 6 Reliability and Validity Evidence for Existing Digital Information Literacy Assessments

Assessment	Author/year	Participants and sample size	Reliability	Validity evidence
Information Literacy Test (ILT)	Cameron et al. (2007)	524 sophomore James Madison University students	$\alpha = .88$ for total test. α for standards 1, 2, 3, and 5 ranged between .48 and .76.	On average the sophomore group passed nearly 70% of items and exhibited good reliability.
		3 subject matter experts (SMEs)		SMEs (university reference librarians) rated alignment of each of the 60 items with ACRL standards. For 70% of items, all raters agreed that the standard was met, at least two raters agreed on 93% of the items (content validity).
		121 JMU Intro Psychology students (75 first year, 46 sophomores)		Sophomores outscored first year students. ILT was significantly correlated with cumulative GPA ($r = .20$). ILT scores were correlated with two self-report items: "confidence in ability to find books and scholarly articles for project[s] of interest" and "confidence in ability to evaluate resources for their quality."
		946 JMU students (422 first year, 524 sophomores)		Mean score for sophomores was significantly higher than mean score for first year students.
	Miller (2004) as cited in Cameron et al. (2007)	333 sophomore JMU students		Construct validity: Most of the students reported in Cameron et al. (2007) had also taken the Information Seeking Skills Test (ISST) as first-year students. For a subsample of 333 students, ILT was significantly correlated with ISST ($r = .38$). After removing 36 unmotivated students (based on timing data) this correlation improved ($r = .45$).
	Wise et al. (2009).	683 first year students at four 4-year institutions	$\alpha = .84$ for total test. α for subscales between .53 and .69.	Scores for 683 students were compared to sample of 422 first-year students; the JMU group scored significantly higher than the larger group ($d = 0.13$).
		839 first year students at five 2-year institutions	$\alpha = .84$ for total test. α for subscales between .50 and .70.	Scores for 839 students were compared to sample of 422 first-year students; the JMU group scored significantly higher than the larger group ($d = 0.17$).
	Gross and Latham (2007)	51 first year students at FSU (33 top quartile, 18 bottom quartile)		Students were labeled as top ($n = 33$) and bottom ($n = 16$) quartile of first year students based on GPA and ACT/SAT scores. ILT scores were significantly different between two groups, with top quartile of students performing better on ILT. These students reported having had more instruction in information literacy.
SAILS	Project SAILS (2015a, 2015b)	Not specified		SAILS/ILT correlation of $r = 0.67$ ($r = 0.72$ adjusted for reliability).
	Radcliff et al. (2015)	61,099 students across 72 institutions taking the test in Spring 2014	Item reliability estimates for cohort test exceed .80	SAILS scores increase with year in college (first through senior), and this is true for all skill sets at all 4-year institutions. Doctorate degree granting institutions show the highest performance (no group comparisons reported).
	Radcliff and Salem (2006)	42,304 students (25 majors) across 82 participating institutions in the United States and Canada	$\alpha > .80$ for all skillsets (subdomains)	Students who scored higher on SAT/ACT scored higher on SAILS (no correlation reported). Student performance on SAILS was strongly correlated with performance on tasks based on the ACRL standards (no correlation reported), but authors note that questions and tasks may have been too easy for students.

Table 6 Continued

Assessment	Author/year	Participants and sample size	Reliability	Validity evidence
		Subject matter experts (number not specified)		Librarian ratings of difficulty compared to statistical item difficulty from student data showed “moderate to high correlation for most items” (no correlations reported).
		18,990 students across 60 US institutions (third wave of development sample)		Observed some differences in performance between Associates granting institutions ($n = 8$) compared to all other types ($n = 52$), but differences were not significant for most subdomains. History majors outperformed others on 4 subdomains, while business majors outperformed others on one subdomain (evaluating and revising search results). Items related to accessing, evaluating and selecting sources and legal issues of information use were most likely to show improvement from first-year to senior students.
	Hill et al. (2013)	An unspecified number of first year and senior students at University of Arkansas-Little Rock (68% first-year)		Results for UALR compared to SAILS overall population and benchmark figures. First year UALR students scored lower than all first-year students on seven of eight subdomains, while senior UALR students performed comparably to all senior students at doctoral institutions and across institution types. Within the school, seniors outperformed first-year students on all subdomains.
	Mery et al. (2011)	1,000 students enrolled in online information literacy course at the University of Arizona		Authors developed their own local IL assessment with 125 items and compared performance to SAILS for evidence of convergent validity. Two separate sets of test items correlated with a randomly-selected subset of 25 SAILS items at $r = 0.67$ and $r = 0.53$.
	Detlor et al.(2011)	1,087 undergraduate business students across three Canadian institutions (949 school A, 66 school B, 72 school C)		Researchers reported that SAILS was useful for assessing information literacy skills of business students; Performance on the SAILS test did not differ significantly across the three institutions on the eight skill groups, except for two subdomains (on Using finding tool features, School A outperformed B and C, while on Understanding economic, legal and social issues, School B outperformed both A and C). Authors interpreted these differences as due to DIL instructional practices at each of the schools.
	Lym, Grossman, Yannotta, and Talih (2010)	53 library instruction coordinators who had administered SAILS		Surveyed SAILS administrators about sampling procedures, development of demographic questions, involvement of statisticians, and correlation of SAILS results to institutional data. Of those surveyed, 69.8% ($n = 30$) did not correlate SAILS with other measures, but 30.2% ($n = 12$) did; SAILS results were mainly correlated with GPA (no correlations reported).
	O’Connor et al. (2001)	91 students at Kent State University		No clear relationship to high school GPA. Reported that for some items, high ability students were more likely to respond correctly than low ability students (based on ACT/SAT score), but this pattern was not consistent across items (no correlations reported).
RRSA	Ivanitskaya (2011)	246 first year students at a four-year college	$\alpha = .82$ for objective items (α from .52 to .76 for subdimensions) α from .66 to .86 for self-report items	

Table 6 Continued

Assessment	Author/year	Participants and sample size	Reliability	Validity evidence
		846 masters-level students in a distance learning program	$\alpha = .78$ for objective items (α from .59 to .67 for subdimensions) α from .81 to .89 for self-report items	
		1,666 undergraduate and graduate students		RRSA performance is significantly correlated with GPA ($r = .34$).
		116 entry- and 247 upper-level undergraduates		Upper level students score higher on RRSA than entry level (first year) students.
	Ivanitskaya et al. (2006)	308 Students in Health Sciences courses		Students completed the Health-specific version of the RRSA; scores ranged from 37–54 correct (out of 56; 66% to 96% correct). Authors suggest the instrument discriminates among skill levels.
	Ivanitskaya et al. (2004)	Subject matter experts (number not specified)		SMEs (librarians and university professors) reviewed and gave comments that informed item revision. Two raters evaluated the items' coverage of each ACRL standard, and items were written for standards with few items.
		95 pilot participants		Authors report that scores on a pilot test were significantly positively correlated with proxy measures of library use (e.g., exposure to library instruction; no correlations reported). Feedback statements were developed on the basis of pilot test results.
	Ratcliff et al. (2013)	150 students enrolled in CSD courses (72 sophomore, 53 senior, 25 graduate)	$\alpha = .79$ overall; $\alpha = 69$ to .72 for finding scale, and $\alpha = .67$ to .70 for evaluating scale.	Scores on the RRSA increased with student experience, with graduate students scoring significantly higher compared to sophomore and senior students in communication sciences and disorders courses.
Information Skills Survey (ISS)	Catts (2005)	24 subject matter experts		SMEs (academics and reference librarians) agreed that the items measured the intended Standards (content validity); only items for which there was agreement on the Standard were retained.
		224 first year students	$\alpha = .87$ for total test.	Factor analysis of 37 items revealed six factors with Eigenvectors from 6.4 to 1.5 accounting for 41% of the variance; all items loaded on the first factor, with 24 items having loadings greater than .30.
			Range from $\alpha = .78$ for Std. 3 to .35 for Std. 1	
		7 subject matter experts		Concurrent validity examined by comparing the estimate of information literacy level obtained from ISS with librarian ratings (non-parametric estimates range from .31 to .44). Correlation of ISS to librarian ratings was .42.
	Clark and Catts (2007)	198 medical students (86 first-year, 112 fourth-year)	$\alpha = .85$ for first-year, $\alpha = .84$ for fourth-year	First-year students outperformed fourth-year students on all Subscales; authors suggest that fourth-year students in clinical settings use different resources (e.g., talking directly to colleagues).
IC3	Haber and Stoddart (n.d.)	189 subject matter experts		SMEs (IT professionals) ranked importance and frequency of completion in an entry level job for each sub-domain (e.g., Living Online); most tasks were rated important and somewhat frequent.
		260 candidates	KR-20 = .88	A 60 item Beta test was administered to 260 candidates; mean percent correct for Living Online was 78%. These items were reduced to a 45-item test with mean percent correct of 80%.

Table 6 Continued

Assessment	Author/year	Participants and sample size	Reliability	Validity evidence
		402 candidates	KR-20 = .93	Validation study with updated IC3 Standard.
		3943 (136 retest sample) Candidates	KR-20 = .90; Test-retest reliability = .82	Live exam data with updated IC3 Standard.
	Certiport (2003)	Over 270 subject-matter experts		SMEs reviewed alignment of items with test objectives, to verify that the items represented the content (content validity). Results of this review were used to inform item selection (180 from over 250). SMEs conducted additional item review after pilot study.
		Over 500 potential candidates		Pilot study data was used to conduct item analysis. Also conducted group difference analysis, reporting no significant group differences that would suggest that the exam functioned differently for examinees from protected groups (gender, race, age). Authors report that correlations and regressions were conducted (none are reported).
ECDL	Davis and Cleere (2003)	Subject-matter experts (number not specified)		Items reviewed by SMEs, core items ("areas of syllabus that are critical to competency in domain," p. 101) identified through voting and group resolution. All ECDL tests are piloted, which involves statistically evaluating test performance, long-term monitoring by an evaluation group, and applying industry indicators to evaluate reliability and validity of the tests (no statistics are reported).
Collegiate Learning Assessment (CLA+)	Benjamin and Chun (2003)	1,300 students at 14 different colleges		At the institution level, the entire CLA has a correlation of $r = 0.90$ with the SAT. At the student level, the scores on CLA have a correlation of $r = 0.50$ with GPA ($r = 0.65$ adjusted for reliability).
	Klein et al. (2007)	First-year students and seniors		At the student level, the essay section correlates with the SAT at $r = 0.44$ for first-year students and $r = 0.46$ for seniors.
	Klein et al. (2009)	544 freshman and seniors at 11 colleges	$\alpha = .84$ at the institution level	Correlation of CLA with other tasks measuring critical thinking (e.g., MAPP) ranges from .73 to .83.
	Zahner (2013)	Students from four institutions	$\alpha = .43$ to .57 for Forms A and B	Low reliability with CLA+ Performance Task alone; combined reliability with SR section improves to .85 to .87).
PIAAC PS-TRE / Survey of Adult Skills	OECD (2013b)	166,000 adults aged 16–65 in 19 countries (sample sizes range from 4,500–27,300 per country)		Of adults surveyed, 14.2% had limited ICT experience, 10.2% opted out of the test, 12.3% scored Below Level 1, 29.4% achieved Level 1, 28.2% achieved Level 2, 5.8% achieved Level 3. Fourteen of 19 countries surveyed outperformed the United States on this scale. Older adults were more likely to lack computer experience or to fail a basic ICT skills pretest. Among 16–24 year olds, 51% score at Level 2 or higher, but US students scored at the bottom of participating countries. Examinees who score higher on the PS-TRE test tend to perform better on literacy and numeracy tests (e.g., adults at Level 3 on PS-TRE tended to be at Level 4 in literacy and numeracy). Educational attainment, parental educational attainment, and level of training have a strong positive relationship to scores (e.g., those adults with less than an upper secondary education are much less likely to score at Levels 2 and 3 compared to adults with tertiary education, p. 188).

Table 6 Continued

Assessment	Author/year	Participants and sample size	Reliability	Validity evidence
	OECD (2013c)	166,000 adults aged 16–65 in 19 countries (sample sizes range from 4,500–27,300 per country)	Test reliability ranged from .80 to .88 across countries	Five 30-m blocks of PS-TRE tasks were field tested and revised prior to main study. Field test results were used to ensure reliability, validity, and comparability of items across countries. Items were selected and revised based on field test data, and a total of 14 PS-TRE tasks were included in main study. Correlations of PS-TRE with literacy range from .68 to .82, while correlations of PS-TRE with numeracy range from .66 to .76. Use of ICT skills at home and work correlated .33 and .22 with PS-TRE in the United States.
iSkills	Katz (2006)	Over 6,300 high school seniors and undergraduates representing 63 institutions		Summarizes task-level data suggesting that many students have difficulty with DIL tasks, such as evaluating information sources, conducting effective searches, and recognizing appropriately narrow research topics.
	Katz (2007)	Content experts (librarians and faculty; number not specified)		Assessment design followed a systematic approach (evidence-centered design; Mislevy, Almond, & Lukas, 2003) that documented the connections among the knowledge and skills to be assessed (construct), observable behaviors that demonstrate students' level of knowledge and skills (evidence), and tasks designed to elicit the targeted behaviors. The assessment and this validity documentation was developed iteratively, including weekly reviews of test content during development of the assessment from January-July, 2004. In addition, "In November 2005, a panel of experts (librarians and faculty representing high schools, community colleges, and four-year institutions from across the United States) reviewed the task content and scoring for the core level iSkills assessment. After investigating each of the thirty tasks and their scoring in detail, the panelists strongly endorsed twenty-six of the tasks. Four tasks received less strong endorsement and were subsequently revised according to the committee's recommendations." (p. 10)
		6282 high school seniors and undergraduates representing 63 institutions	$\alpha = .88$	Post-assessment surveys suggested that students enjoyed taking the test (~60% agreement), found it appropriately challenging (~90%), accurately reflects DIL activities (~78%), and requires thinking skills as well as technical skills (~94%)
	Katz, Attali, et al. (2008)	566 undergraduates	$\alpha = .88$ (task level) and .93 (item level)	Confirmatory factor analyses performed at the task and item levels. Task scores were intercorrelated overall. One factor model fit the data best compared with theoretically motivated seven, four, and two factor models.
		324 call center employees		Administered full form of iSkills composed of tasks with workforce or personal scenarios. Items showed similar difficulty and discrimination as an administration to undergraduates. Correlations of $r \sim .4$ between iSkills and self-reported confidence with DIL activities.
	Katz and Smith-Macklin (2007)	4048 undergraduates from 30 colleges and universities across the United States.	Not calculated due to spiraled design. Cites other administrations with fewer tasks had $\alpha > .85$.	Administration in a spiraled design of a large-scale version of iSkills. High correlations (.80 +) between tasks, so forms treated as equivalent. Correlations with GPA ($r = .23$), self-reported DIL confidence ($r = .27$), and measures of academic self-sufficiency ($rs = .15$ to .29). Discriminant validity: no correlation with self-reported frequency of DIL activities ($r = -.01$, *n.s.*).

Table 6 Continued

Assessment	Author/year	Participants and sample size	Reliability	Validity evidence
	Katz, Elliot, et al. (2008)	155 first-year undergraduates		Administered iSkills and applied locally developed IL rubric based on portfolio of work. iSkills and IL rubrics near zero partial correlation after accounting for SAT scores, suggesting distinct constructs (targeted, time-controlled IL vs. humanities-related writing). iSkills-SAT-M correlation $r = .33$; iSkills-SAT-V $r = .52$. Nonsignificant correlations between iSkills and overall GPA, and between iSkills and writing course grade.
		176 upper-level undergraduates		iSkills and IL rubric scores near zero partial correlations after controlling for SAT scores. Other correlations significant: iSkills-GPA ($r = .27$), iSkills-course grade ($r = .21$), iSkills-SAT-M ($r = .38$), iSkills-SAT-V ($r = .49$).
	Katz et al., Haras, and Blaszczynski (2010)	Undergraduates enrolled in a business writing course (81 native English speakers; 71 English-language learners)		Investigation of predictive validity in pre-post design. Native speakers scored higher than ELLs overall (both pre- and post), and both groups improved from pre- to post. GPA-iSkills correlation $r = .23$ ($p < .05$, native) and $r = .03$ (*n.s.*; ELLs). For both groups, after controlling for GPA, iSkills pretest score accounted for about 10% of variance in final course grade.
	Katz and Elliot (2016)	1823 undergraduate and high school seniors		Reports post-administration survey results. Students agreed or somewhat agreed that the test was appropriately challenging (85%), to perform well required thinking rather than just technology (78%), the test accurately reflects their skills (57%), and reflects real-world tasks (78%). Students also agreed or somewhat agreed that the unfamiliar software was difficult to use (56%) and that they encountered system glitches during administration (48%).
		1442 undergraduate and high school seniors		50% scored above cutscore of 260
	Ali and Katz (2010)	159 human resources consultants and business school faculty from across the United States (of 1540 e-mails sent) and 144 business faculty (of 3711 e-mails sent)		Created two surveys based on ETS ICT Literacy framework. 159 HR consultants rated how essential the skills are for new hires. More than 50% rated all elements as “Important” or “Essential” and more than 60% rated 39 of 41 skill elements in this way. 144 business school faculty rated the degree to which they included these skills in their instruction. Only 9 of 29 skill elements were reported as taught “Frequently” or “Always.” While HR Consultants particularly judged security, legal, and ethical aspects of information use as most important, few business faculty reported teaching these skills.
	Beile et al. (2010)	140 nursing students		Correlations: iSkills—SAILS: .56; iSkills—SAT-V: .42; iSkills—SAT-M: .35; SAILS—SAT-V: .42; SAILS—SAT-M: .16 (*n.s.*); iSkills—Course Grade: .24; SAILS—Course Grade: .13 (*n.s.*).
	Hignite et al. (2009)	600+ first-year undergraduates		About 40% scored above cutscore of 165. Females ($N = 344$) scored higher than males ($N = 269$; 156 vs. 151). Caucasian ($N = 526$) scored higher than non-Caucasian ($N = 86$; 157 vs. 136). However, no information given on English-language status of latter group (as a highly verbal test, lower scores for ELL students has been found before). Higher self-reported ACT scores corresponded with higher iSkills scores.

Table 6 Continued

Assessment	Author/year	Participants and sample size	Reliability	Validity evidence
	Snow and Katz (2009)	88 undergraduates (11 provided concurrent verbal protocols)	Scores on naturalistic tasks: kappa = .84; $\alpha = .46$. iSkills tasks: $\alpha = .52$.	Administered eight iSkills "evaluate" tasks and four naturalistic tasks (designed from homework assignments) targeting "evaluate" and "integrate" skills. $r = .19$ (uncorrected) and .40 (corrected). "The evidence based on response processes indicates that the observed correlation … represents desired, rather than spurious, relationships. … students responded to the iSkills evaluate tasks with knowledge and reasoning both specific and irrelevant to the ICTL evaluate domain. Responses from the iSkills evaluate tasks moderately corresponded with verbal responses from the naturalistic evaluate tasks." (pg. 123).
	Tannenbaum and Katz (2008)	23 content experts recruited internationally		Modified, extended Angoff methodology to set a cutscore. Cutscore set to 260.
		642 undergraduates and high school seniors		This sample participated in a pilot administration of iSkills (called iCritical Thinking at the time of the study). Based on a cutscore of 260, 48% of the sample would be characterized as possessing a foundational level of digital literacy.
	Wallace and Jefferson (2015)	76 undergraduates enrolled in a first-year orientation seminar		25 students received a critical thinking workbook; the remaining 51 students did not. Overall, 20% scored above 240, the cutscore reported by the authors. 36% of workbook students scored above 240, while only 12% of control students did so ($X^2(1) = 6.22$, $p < .05$). Integrate and Manage subscores were different between the groups, with the treatment group scoring higher. Time to complete test differed significantly between the groups, but no mean times were reported.
	ETS (2007)	1804 undergraduate students		Students at universities with first-year students having above average SAT scores scored higher on iSkills than students at less selective institutions. Unclear relationship between iSkills score and year in school.
		820 high school seniors and 2559 undergraduate students		Among high seniors, those intending more rigorous postsecondary education scored higher. On average, high school seniors scored lower than current community-college students, who scored lower than students currently at a four-year institution. Unclear relationship between iSkills and year in school.

reliabilities ($\alpha = .59$ to .67) for RRSA decreased relative to the undergraduate sample (overall $\alpha = .82$), whereas reliabilities for the self-report items increased for master's ($\alpha = .81$ to .89) as compared to undergraduate students ($\alpha = .66$ to .86). A mixed-grade sample of students (sophomores, seniors, and graduate students) from courses in communication sciences and disorders showed similar reliability estimates to the master's level sample (overall $\alpha = .79$, $\alpha = .67$ to .72 for subscores; Ratcliff, Swartz, & Ivanitskaya, 2013). The iSkills assessment does not provide subscore reliabilities, citing results from factor analyses suggesting a unidimensional construct (Katz, Attali, et al., 2008; see the "Construct Validity" section). Of course, even subscores that achieve acceptable levels of reliability might not provide information about students' knowledge and skills beyond what the total test score provides (cf. Sinharay & Haberman, 2008), an issue we return to in the "Score Reporting Considerations" section.

In sum, most DIL assessments reviewed demonstrate good reliability, mostly due to their reliance on multiple selected-response items, which tends to increase reliability relative to tests with fewer items.

Content Validity

Content validity evidence involves examining the correspondence or alignment of assessment items and the subject matter domain being assessed (i.e., DIL). Content validity is often evaluated by asking subject matter experts or test users to make judgments of the alignment between test content and curriculum or standards; this type of expert review was conducted as a part of the validation efforts for a number of assessments. For example, assessments aligned to information literacy standards have examined university librarians' judgments of the alignment of test items to those standards, with test developers using the data to revise or eliminate items; this approach was used for ILT (Cameron et al., 2007) and RRSA (Ivanitskaya, Laus, & Casey, 2004), both aligned to the IL standards (ACRL, 2000), and the ISS (Catts, 2005), which is aligned to the ANZIIL framework (Bundy, 2004). Using a slightly different approach, SAILS (Radcliff & Salem, 2006) compared librarians' ratings of item difficulty to statistical item difficulty estimates, reporting moderate to high correlations between these estimates. Technology-focused assessments also provide content validity evidence. As part of the design process for the IC3, information technology professionals ranked the importance and frequency with which each target task was required in entry level jobs (Haber & Stoddart, n.d.), and over 250 experts provided a review of the alignment of test items with the intended objectives, which was used to inform item selection (Certiport, 2003). Similarly, developers of ECDL asked subject matter experts to review items and identify those that are critical to competency in the domain; an evaluation group provides continued review as new items are developed and piloted (Davis & Cleere, 2003).

With respect to the content validity of performance-based assessments, we focus on evidence associated with the iSkills assessment, which used an evidence-centered design approach (Katz et al., 2004; Mislevy, Almond, & Lukas, 2003) in which tasks were designed specifically to provide evidence of particular components of the construct (i.e., the seven task types described previously). Content validity was considered during the assessment development process by asking a panel of librarians and faculty across multiple education levels (high school, community college, and 4-year institutions) to review task content and scoring for 30 tasks; 26 of these were strongly endorsed by the panel, with the remaining four tasks being revised based on expert feedback (Katz, 2007). Further evidence of content validity for iSkills is provided by Ali and Katz (2010), who examined the relevance of DIL skills to business contexts by surveying a sample of 159 human resource consultants, finding that over half rated the elements as important or essential for new hires; further, a survey of 144 business school faculty revealed that despite the perceived importance of DIL skills, few of these were noted as frequently or always taught. Overall, the assessments reviewed took considerable effort to validate the content of the assessment items, in terms of either their alignment with academic standards or their correspondence with the skills that are required for success in the workforce.

Construct Validity

Construct validity concerns the extent to which a measure assesses the intended underlying theoretical construct. Few of the assessments we reviewed had published evidence of construct validity, in terms of examining the internal structure of the assessment. Construct validity evidence is provided for the ISS by way of a factor analysis conducted on responses from a sample of 224 first-year undergraduates (Catts, 2005); this analysis revealed six factors with Eigenvectors greater than 1.0, which accounted for 41% of the variance in scores; further, all items loaded on the first factor, with 24 of 37 receiving loadings exceeding .30. The construct validity of the iSkills assessment was examined using a confirmatory factor

analysis (Katz, Attali, et al., 2008); this analysis revealed that a one-factor model had a better fit to the data as compared to seven-, four-, and two-factor theoretical models. Taken together, the limited construct validity evidence suggests that the DIL construct is unidimensional; this could help to explain the low subscore reliability estimates for assessments that report them.

Relation to Other Variables

Another form of validity evidence involves inspecting the relationship between assessment performance and performance on other measures given at the same or similar times (i.e., concurrently). Convergent evidence is for measures expected to be related (either positively or negatively) to the assessment, whereas discriminant evidence is for measures expected not to be related to the assessment (i.e., having zero correlation). The pattern of convergent and discriminant measures provides a picture of the construct assessed by the assessment of interest. This pattern aids interpretation of assessment performance by painting a picture of the knowledge and skills that tend to be related and unrelated to the target construct. In some cases, there might be a theory to predict the expected relationships; in other cases, the inspection of concurrent measures might be more exploratory, such as when a construct that has not been extensively studied is the intended construct for an assessment. Across the DIL assessments we reviewed, the majority of validity evidence available concerns inspecting relationships between particular DIL assessments and other variables of interest, with studies reporting correlations of test scores with other measures of information literacy skills, such as librarian judgments (Catts, 2005), self-report items (Cameron et al., 2007; Ivanitskaya, O'Boyle, & Casey, 2006; Katz, Attali, et al., 2008; Katz & Smith-Macklin, 2007; OECD, 2013c), or other DIL assessments (Beile, Dziuban, Katz, & Salem, 2010; Cameron et al., 2007; Katz, Elliot, et al., 2008; Klein et al., 2009; Mery, Newby, & Peng, 2011; OECD, 2013c; Project SAILS, 2015b), as well as correlations with more general academic measures, such as year in school (Cameron et al., 2007; Clark & Catts, 2007; ETS, 2007; Hill, Macheak, & Siegel, 2013; Ivanitskaya, 2011; Klein et al., 2007; Radcliff et al., 2015; Ratcliff et al., 2013), grade point average (GPA; Benjamin & Chun, 2003; Cameron et al., 2007; Gross & Latham, 2007; Ivanitskaya, 2011; Katz, Elliot, et al., 2008; Katz, Haras, & Blaszczynski, 2010; Katz & Smith-Macklin, 2007; O'Connor, Radcliff, & Gedeon, 2001), or *SAT*®/ACT scores (Beile et al., 2010; Benjamin & Chun, 2003; ETS, 2007; Gross & Latham, 2007; Hignite, Margavio, & Margavio, 2009; Katz, Elliot, et al., 2008; O'Connor et al., 2001; Radcliff & Salem, 2006).

Studies have typically found a positive relationship between DIL assessments and several general academic ability measures. For example, researchers have reported correlations in the .4 to .5 range between iSkills and SAT-Verbal scores and approximately .35 for iSkills and SAT-Math scores (Beile et al., 2010; Katz, Elliot, et al., 2008). Similarly, for SAILS, Beile et al. (2010) reported a correlation of .42 for SAILS and SAT-Verbal as compared to a nonsignificant correlation of .16 with SAT-Math, although the relationship between SAT and SAILS performance is reported to be inconsistent across items (O'Connor et al., 2001). The higher correlations for SAT-Verbal are not surprising given the amount of reading and verbal reasoning inherent in measures of information literacy, although the magnitude of these correlations suggests that DIL reflects a separate construct from reading and writing literacy per se. Hignite et al. (2009) similarly reported that higher ACT scores were related to higher iSkills scores. Examinations of the CLA+ reveal that the overall test correlates $r = .90$ with SAT at the institution level (Benjamin & Chun, 2003), while at the student level, the performance task essay is correlated with SAT at $r = .44$ and .46 for first-year and senior students, respectively (Klein et al., 2007). For the PIAAC Survey of Adult Skills, correlations are computed among the three scales of the survey; correlations of PS-TRE with literacy range from .68 to .82, while correlations between PS-TRE and numeracy (i.e., mathematics) range from .66 to .76 across the 19 countries that participated in the PS-TRE assessment (OECD, 2013b). In general, DIL assessments show moderate to high correlations with standardized cognitive assessments.

With respect to GPA, correlations are somewhat lower; at the student level, CLA+ correlates $r = .50$ with GPA (Benjamin & Chun, 2003), as compared to a correlations of .20 between cumulative GPA and the ILT (Cameron et al., 2007) and .34 between GPA and RRSA performance (Ivanitskaya, 2011). Correlations between GPA and iSkills have been more variable, ranging from zero to moderate correlations, whether that GPA is self-reported ($r = .23$ in Katz & Smith-Macklin, 2007; $r = .23$ for native English speakers in Katz et al., 2010) or pulled from school records ($r = .08$ for first-year students and $r = .27$ for sophomores, juniors, and seniors in Katz, Elliot, et al., 2008). Correlations between DIL assessments and course grades are low for iSkills ($r = .24$ in Beile et al., 2010; $r = .21$ in Katz, Elliot, et al., 2008) and are nonsignificant for SAILS ($r = .13$; Beile et al., 2010). Further, SAILS shows no relationship to high school GPA (O'Connor et al., 2001).

Results for year in school generally show increased performance on DIL assessments with increasing school experience (Cameron et al., 2007; Hill et al., 2013; Ivanitskaya, 2011; Radcliff et al., 2015; Ratcliff et al., 2013); for SAILS, items related to accessing, selecting, and evaluating sources are most likely to show improvement from first-year to senior students[2] (Radcliff & Salem, 2006). The RRSA shows significantly higher performance for graduate students as compared to both seniors and sophomores (Ratcliff et al., 2013); further, for SAILS, the type of institution matters, with students attending doctoral-degree granting institutions performing better than other institutions (Radcliff et al., 2015). Results from the PIAAC PS-TRE survey also show that examinees' educational attainment, parental educational attainment, and level of training are strongly positively related to scores (OECD, 2013b). The self-report ISS is an exception to the general pattern; research shows that first-year medical students outperform fourth-year medical students on all subscales (Clark & Catts, 2007), which the authors suggest reflects the fact that advanced medical students working in clinical settings use different resources for information gathering, such as relying on conversations with their supervising physician or other colleagues, rather than using digital and text sources. In general undergraduate settings, however, DIL assessments appear sensitive to the development of those skills throughout the college experience; results for the ISS suggest that this measure may not be sensitive to discipline-specific methods of accessing and evaluating information, which students may be asked to master as they enter into graduate or professional education within a domain.

Other studies have reported convergent evidence that DIL assessments correlate with measures thought also to reflect digital literacy skills; one area that has been examined is relations with self-report measures. For example, in a study of iSkills, Katz and Smith-Macklin (2007) administered a self-report measure of information literacy skills, a 30-item questionnaire on test takers' confidence in their ability to perform DIL activities. The activities were created based on the iSkills digital literacy framework. The researchers reported a correlation of $r = .27$ between iSkills and overall DIL confidence. Interestingly, simply performing these activities (i.e., being asked to rate the frequency of these activities) was not correlated with iSkills performance, which suggests that frequent DIL activity does not necessarily lead to stronger DIL skills. Katz and Smith-Macklin reported results for college students, but similar results were obtained when iSkills was administered to a sample of adult workers at a call center, with correlations of approximately .40 between iSkills and self-reported confidence (Katz, Attali, et al., 2008). Confidence ratings have also been examined for the ILT, with Cameron et al. (2007) reporting that ILT scores are correlated with self-reports of confidence in finding books and scholarly articles for research projects and confidence in source evaluation skills. Studies of the RRSA similarly report that test scores are positively correlated with proxy measures of library use, such as self-reported exposure to library instruction (Ivanitskaya et al., 2004), yet no specific correlation coefficients are reported. Among US adults, self-reports of use of information communication technology at home and in the workplace are correlated .33 and .22 with performance on the PIAAC PS-TRE (OECD, 2013c). In contrast to these self-report measures, convergent validity evidence for the ISS was provided by librarian ratings of students' information literacy skills; these expert ratings were correlated $r = .42$ with scores (Catts, 2005), suggesting that these experts may provide more precise estimates of DIL proficiency as compared to students' self-perceptions; however, this is the only study that provided such evidence, and self-reports are likely easier to obtain because they can be presented within the same testing session as more objective items (as in the RRSA). However, Rosman, Mayer, and Krampen (2014) cautioned that correlations with self-report judgments might be overestimates if the self-report measure was administered after the information literacy assessment.

Other validation efforts have examined correlations among DIL assessments and other measures designed to assess the same or similar constructs. For example, the CLA+ performance task is highly correlated ($r = .73$ to .83) with other measures of critical thinking (e.g., Measure of Academic Proficiency and Progress [MAPP]; Klein et al., 2009). The ILT is significantly correlated ($r = .38$) with the ISST, a predecessor DIL measure developed for use within James Madison University, on which the design of the ILT was based (Miller, 2004, as cited in Cameron et al., 2007). This correlation, based on a sample of 333 students who had taken both tests, improved to .45 after removing unmotivated students, identified on the basis of timing data. ILT is also highly correlated with SAILS ($r = .67$, $r = .72$ adjusted for reliability; Project SAILS, 2015b), which has been shown to correlate with locally developed IL assessments ($r = .53$ to .67; Mery et al., 2011). Further, studies have found positive correlations between SAILS and the iSkills assessment ($r = .56$), based on a small sample of 50 undergraduates (Beile et al., 2010). In all of these cases, the correlations suggest that existing assessments tap similar knowledge and skills related to DIL.

To further examine the convergent validity of the iSkills assessment, Snow and Katz (2009) administered a set of iSkills "evaluate" tasks and performance on homework-like evaluation tasks. The performances of 88 undergraduates were

correlated at $r = .19$ (this increased to .40 after correcting for low reliability of the homework-like tasks). A more extensive study compared performance of several samples of undergraduates on iSkills and an information literacy rubric in use at the university (Katz, Elliot, et al., 2008). Across several samples that included first-year students, sophomores, juniors, and seniors, the researchers observed little connection between iSkills scores and rubric scores for students' writing portfolios. The relation between iSkills scores and other academic ability measures were largely replicated as in previously cited studies. The researchers concluded that the type of information literacy skills tested by iSkills involves more goal-directed and time-limited skills compared with the semester-long portfolios and, so, taps different constructs. This conclusion is supported by another study that demonstrated an alignment between iSkills scores and grades in a business-writing course (Katz et al., 2010). Overall, then, while iSkills and other DIL assessments appear to measure a similar construct, these constrained instruments do not completely correspond to the range of information literacy experiences that students encounter in their coursework.

Evidence Based on Test-Criterion Relationships

An assessment may be used for placement, either with respect to placing out of an otherwise required course or being asked to take a remedial course in order to further develop one's limited skills. In either case, validity evidence should be collected so that performance on the assessment in some way is predictive of performance in the course to be taken or skipped. If it can be shown that performance on the assessment taken before a course is related to students' performance in the course (e.g., final course grade), it strengthens the validity argument for the use of the assessment for placement. A familiar example of predictive validity is the SAT exam, which is designed to predict first-year GPA in a 4-year college (Bridgeman, McCamley-Jenkins, & Ervin, 2000; Morgan, 1989). Although the SAT is a selection, rather than a placement exam, a similar validity logic holds. A typical predictive validity study for the SAT follows a cohort of students who took the SAT into their first year at college. Regression analyses are used to show the predictive power of the SAT score on first-year GPA after controlling for other factors (e.g., gender, ethnicity, parental education, family income) and in comparison to other possible predictors, like high school GPA.

Across the assessments we reviewed, limited evidence of test-criterion relationships (for prediction) was available; to our knowledge, the iSkills assessment was the only measure for which published evidence was available. A study was conducted using iSkills as a predictor for performance in an analytical business writing course at a college in California. Katz et al. (2010) administered the iSkills assessment to two cohorts of undergraduate business majors: native English speakers and nonnative English speakers. Regression analyses demonstrated a significant relationship between the beginning-of-course iSkills scores and end-of-course grades for both cohorts. The researchers reported that iSkills accounted for about 10% of the variability in each cohort's final grades, after controlling for students' general academic ability (i.e., GPA). This degree of prediction corresponds to students who did well on iSkills being approximately six times more likely to earn an A in the class compared with students who performed poorly on iSkills. This study provides validity evidence for the use of iSkills as a prescreener for a business writing course; for example, students who perform poorly might be asked to take a remedial course that covers the basics of conducting a focused search of a literature and communicating conclusions reached through synthesis and evaluation of the identified information (i.e., skills covered in business writing courses). Thus, while the iSkills assessment shows some evidence of predictive validity in business writing contexts, the predictive validity of other DIL assessments has been understudied (and perhaps underreported) in the literature.

Summary of Validity Evidence

Across the assessments included in the current review, several conclusions may be drawn. First, assessments of DIL appear to capture the construct as defined by academic standards, workforce requirements, or other theoretical conceptions of the DIL construct, despite some variation in what is measured across these various instruments. Second, it appears that performance on DIL assessments is moderately to highly correlated with other measures of this construct, as well as more general measures of academic success, such as GPA or course grades. Because DIL skills are associated with academic success, and because these skills appear to develop over the course of students' undergraduate and graduate training, it is important to obtain valid measures of these skills for use in evaluating the extent to which students possess DIL proficiency across various institutional contexts. The preceding review provides an overview of currently available measures that

institutions could choose to implement; in the following section, we turn to a discussion of important characteristics of and considerations for the design of a new DIL assessment, which could serve as a measure of SLOs.

Proposed Characteristics of a Digital Information Literacy Assessment

An operational definition of the DIL construct (like that proposed in Table 3) forms just one component of the assessment design considerations; beyond a specific construct definition, assessment developers must consider several other issues, such as the contexts in which information is to be accessed, evaluated, and used; the extent to which particular technology applications are included and whether use of the technology constitutes a context for problem-solving or is an assessment target in its own right; and considerations related to scoring. We discuss each of these issues in terms of their implications for design of a next-generation assessment of DIL as an SLO. Often, a primary driver of the selection among alternative assessments is the extent to which a given instrument aligns with the intended construct; this is particularly important given the evolving nature of conceptions of DIL. Given the integrative nature of our proposed DIL construct definition, the close alignment of the iSkills assessment design with this definition, and the extensive validity evidence available for the performance-based tasks used in iSkills, we primarily use the design features of that assessment as a basis for our discussion and subsequent recommendations.

Defining an Evolving Construct

Developers appear to take one of two approaches when considering how to operationalize the construct of DIL for purposes of developing assessments. The first constitutes identifying a particular framework or standard that aligns with the developers' definition of the construct and then writing items aligned to those objectives or components of a standard. Instruments of this type, which are based on particular standards or objectives, would be of interest to administrators who want to assess a discrete set of skills. For example, a definition of information literacy as "the ability to successfully conduct information searches" (Rosman et al., 2014, p. 741) suggests that the use of search and retrieval tasks should be sufficiently representative to measure competency with information literacy. This method contrasts with those of developers who operationalize the construct at a more conceptual level, thus allowing for the creation of real-world tasks that measure the construct more broadly and more authentically. Assessments developed from this perspective may be of interest to administrators who define the construct more holistically and are interested in whether students can deploy these skills in the context of real-world applications in which those skills are required. Ultimately, the intended learning objectives for a given information literacy program and the operational definition on which an assessment is based should be well aligned for the test to be considered appropriate.

Possibly the most significant attempt to change the definition of information literacy has been the recently adopted IL framework (ACRL, 2015). In comparing the IL framework to the previous IL standards (ACRL, 2000), it is clear that an attempt is being made to better communicate the nature of information literacy skills. The IL standards could be interpreted as defining information literacy as a list of component information literacy skills because each standard is followed by a list of performance indicators—that is, behaviors indicative of elements of information literacy competency. The definitions of skills and performance indicators in the IL standards might have suggested to many that these component pieces compose the entirety of the information literacy construct. Perhaps unintentionally, such an atomistic approach to standards suggests a particular way of teaching information literacy, through the incremental and piecemeal accretion of the individual skills. That is, to teach information literacy, students must learn each of the constituent parts as outlined in the IL standards. For example, Katz and Elliot (2016) described this viewpoint in the way that educators wanted to use the iSkills assessment. Some educators wanted scores on subskills within the assessment to know which subskills their students were weak on, so that they could then increase instruction on those subskills. This approach represents both an inappropriate use of the test (subscores are not sufficiently reliable and highly intercorrelated), as well as treating DIL as a set of distinct subskills, and fails to properly take into account the integrative, purpose-driven nature of the construct. The whole of information literacy is greater than the sum of the parts as listed in the IL standards.

In contrast, through the updated IL framework, the ACRL appears to have adopted a less atomistic and more holistic view of information literacy (and, by extension, DIL). The IL framework is organized around six "big ideas," which are deliberately described at a high level, perhaps in the hope that instructors will be forced to think deeply about the big ideas and how those ideas might be taught, and internalized, by students. These big ideas reflect a more integrative organization

of the IL skills encompassed by the original standards, and accordingly, some current DIL assessment developers have already proposed alignments between their test and the six big ideas from the IL framework (e.g., ILAAP, 2015). Other assessments remain relevant because they do not overrely on the specific definitions and performance descriptors apparent in the earlier IL standards. For example, the alignment between the IL standards and the iSkills test was deliberately done not at the level of the individual tasks, but between the standards and descriptions of performance indicators (i.e., the observable behaviors elicited by tasks as evidence of knowledge and skill; Katz et al., 2004). These performance indicators motivated the construction of iSkills tasks as well as the design of the scoring algorithms for each task. Thus, it is only in the broadest sense (the task types) that the tasks are aligned to the original IL standards.

As performance tasks, the iSkills tasks were designed to embody rich, interactive performances that capture a range of lower level skills, but in an integrated way, that reflects how information literacy skills and knowledge are used in real-world tasks. This approach — from the design of the assessment right through to the scenario-based nature of the tasks — differs from those of most existing DIL assessments. The iSkills tasks were designed to elicit certain behaviors that are indicative of pieces of the construct, but the assessment is at the level of the entire construct. The iSkills assessment differs from a multiple-choice test, even one based on IRT, because the test is not designed to have one-to-one correspondences between the individual items and pieces of the IL standards, but rather to integrate skills that cover several elements of the standards as is natural in more real-world performances. It is true that the iSkills tasks fall short of true real-world performance. For example, Snow and Katz (2009) demonstrated how test takers spent more time trying to figure out what an iSkills task was asking them to do compared with a more direct focus on the solving the task that was seen in the verbalizations of test takers when they solved parallel, but more naturalistic, homework-like tasks. Nevertheless, the iSkills tasks, by creating a scenario-based context and requiring simulated performances, seems to reflect a more holistic view of the information literacy construct compared with tests that require relatively simpler actions (e.g., selecting from options, moving objects on the screen, or demonstrating a particular path to do something in simulated software), and whose items are designed to have 1:1 mappings with elements of the IL standards.

Real-World Scenarios

DIL are skills applied in the real world. In the workplace, school, and personal lives, we engage with information in the context of digital tools and media. This engagement is necessarily interactive: we seek information, we learn about a topic and thereby change the way we look for further information, and we make decisions about the quality of different information sources that affects our interpretation of the information we get from those sources. To align with the interactive nature of the domain, an authentic assessment should be similarly interactive, or performance-based, and embedded in a real-world context; this approach is exemplified by the interactive tasks included in the PS-TRE and iSkills assessments.

The real-world scenarios should reflect the range and complexity of contexts in which DIL activities occur, whether in the workplace, through academic work, or in one's personal life. Workplace scenarios might focus on creating analytic syntheses of business information, perhaps to support decision-making (e.g., a memo describing characteristics of a competitor's products). School-based scenarios might include typical classroom assignments encountered in college, such as evaluating alternative sources of information to use in a writing assignment or creating a presentation to summarize a research project to one's classmates. Personal life scenarios might include such activities as conducting internet searches to help a family member solve a problem or reorganizing files to make them easier to find later. For example, a recent experience-sampling survey conducted by the Pew Research Center (A. Smith, 2015) reveals that a majority of younger adults ages 18–29 report using their smartphones for various everyday purposes, including accessing information about health conditions, real estate, and employment opportunities, in addition to educational content. These real-world scenarios that are relevant to the ways in which college-aged populations access and make use of digital information can help motivate examinees' interactions with such information, providing a setting in which access, evaluation, and use is driven by specific, meaningful goals.

A challenge to providing real-world scenarios is the rapid pace of changing technology. Scenarios that seemed current just a few years ago (e.g., instant messaging or e-mail) often are replaced by more current technologies (e.g., text messaging, video messaging). Although the underlying cognitive skills associated with DIL might not change as rapidly as we discuss here, assessments should be subject to periodic reviews to ensure that the technologies and situations depicted remain current and relevant to higher education students.

Focus on Measurement of Cognitive Rather Than Technology Skills

The review of frameworks presented earlier suggests a wide range of views on DIL, from a primarily technical set of skills (i.e., technical computer literacy) to largely cognitive skills that need not be associated with use of digital technology (i.e., traditional information literacy). Our proposed operational definition (Table 3) bridges these approaches, focusing on measuring cognitive skills in the context of digital technology applications rather than measuring use of technology for its own sake or cognitive skills devoid of a technology-infused environment. This approach has the advantage of being relatively impervious to rapid changes in technology. Although recent years have seen large changes in technology and the technological contexts of engaging with information, the cognitive skills involved in appropriate use of information have remained largely stable since the first definition of information literacy appeared in the 1970s (Zurkowski, 1974). What has changed considerably are the ways in which we define or enumerate those skills. As previously described, the early ACRL (2000) definition implied a somewhat elemental approach to information literacy as a set of specific skills to be acquired. The more recent IL framework (ACRL, 2015) takes an approach more akin to Bruce's (1997) view of information literacy as a set of increasingly sophisticated views on information, which are mutually supportive. That is, the more recent IL framework recognizes and emphasizes the integrative (vs. elemental) view of information literacy.

An assessment should similarly represent such an integrative view of digital information, rather than treating each item as measuring a single, isolated assessment target. Tasks might involve extended performances that engage several aspects of DIL skills over multiple actions or activities. Of course, for the purposes of designing an instrument with good construct validity, we must have some documentation of construct coverage so tasks could be assigned to particular aspects of the DIL construct. However, rather than focusing very tightly on low-level skills, the assessment tasks should take a broader view of the domain and reflect the contexts in which application of DIL skills is required. Assessment items that target a shallower understanding of the domain are more typical of multiple-choice or simple constructed response testing formats, as opposed to richer, more extended interactions with simulated software. We advocate the use of these simulation tasks to obtain better evidence of students' ability to deploy DIL skills in the technological contexts of their use.

Use Minimal and Highly Familiar Technology Elements

Because technology per se is not a focus of a DIL assessment, knowledge of particular applications or particular software functions should not be necessary to do well on the assessment. An assessment should assume only that test takers are familiar with broad classes of software applications (word processors, browsers, presentation tools), software functions (copy-and-paste, menus, file management, clicking), and hardware (mouse and keyboard) rather than a specific tool or application. This baseline level of expected technology know-how should be made known to test takers to allow them to prepare for the assessment.

Such a minimalist focus on technology has some benefits. Many of these basic software functions have been part of consumer experience with technology, almost unchanged, for several decades (e.g., many tools share common graphical interfaces or similar design language, such as menu commands and toolbar icons). In other words, these functions represent aspects of technology that have remained remarkably stable despite the overall fast-paced, changeable nature of technology. Thus, the minimalist functionality of software will help the stability of the assessment; it might not be necessary to change the assessment to accommodate new technology nearly as often as would be needed for an assessment that targets specific technological knowledge (e.g., knowledge of particular software applications).

In addition to this logistical benefit, minimalist technology may support test fairness. Even if technology is ubiquitous, people differ in their familiarity with particular software applications and interaction techniques. For example, Pew surveys reveal that 85% of US adults are online and 67% of adults use smartphones (Duggan, 2015). Despite this prevalence of access, some adults are heavily dependent on particular methods of going online — such as via their smartphones — and have limited means for accessing online content from other devices (i.e., laptop or desktop computer with a broadband internet connection). Such "smartphone dependent" individuals represent approximately 19% of the adult population, including 15% of adults age 18–29 (A. Smith, 2015). These results suggest that many college-aged students (i.e., potential DIL examinees) may have little experience with using a desktop computer as a primary means of going online. Further, smartphone dependence disproportionately affects low-income (13% for household incomes under $30,000 vs. 1% for household incomes over $70,000) and non-White adults (12% for African Americans and 13% for Latinos vs. 4% for White respondents).

Caution should be taken so that the technology aspects of a DIL assessment do not favor or hinder performance simply because a person is more familiar with a particular browser or other software environment (Katz & Gorin, 2016). Similarly, the changing nature of access to digital information also suggests that such assessment should take care not to limit the design of tasks to those that can be accomplished using a desktop computer, but should also consider the extent to which smartphone or tablet-based interfaces requiring touch-screen technology might also be incorporated, which would increase the likelihood that test takers from various backgrounds would consider the context of the tasks to be sufficiently familiar that they can engage with the assessment. Minimalist technology in a DIL assessment helps achieve this fairness goal by attempting to put all test takers on a similar level of using software that has minimal, but recognizable functions, and helps ensure that examinees with knowledge of particular software packages or types of hardware do not have an unfair advantage.

Automated Scoring

Some open-ended DIL assessments are scored by human raters using a well-defined rubric. For example, the UK Key Stage 3 ICT exam presents students with contextualized real-world tasks (United Kingdom Department for Education, 2013). The students use simulated, but highly functional software, to produce digital artifacts such as word processed documents or spreadsheets. These rich digital artifacts are scored by human raters. This approach to large-scale, human-scored performance assessment has been implemented by some national testing programs, such as the UK Qualification Authority (Ripley, 2009) and the New Zealand National Educational Monitoring Project (J. Smith, Crooks, & Allan, 2010). Some universities have also taken this approach for information literacy assessment (e.g., New Jersey Institute of Technology [NJIT]; Scharf, Elliot, Huey, Briller, & Joshi, 2007). However, despite the possible benefits in terms of measuring complex constructs, the approach is costly and time-consuming, requiring human raters to be trained, calibrated, and dedicated to spending considerable time in scoring. Automated scoring might be more feasible solution for most colleges and universities.

Automated scoring no longer implies multiple-choice or simple constructed response items; several of the DIL assessments reviewed incorporate some type of performance assessment that is nevertheless automatically scored; assessments such as PIAAC, iSkills, ECDL, and IC3 are all automatically scored, yet these assessments include performance tasks, such as having test takers interact with simulated software. Importantly, automated scoring is applied to both the response data (e.g., the selection of a particular alternative in a drop-down menu) and the process data generated in the course of making those responses (i.e., the sequence of actions that precedes submission of a final response; see Katz & Gorin, 2016). For example, in an IC3 task that requires examinees to print a document, alternative steps toward printing a document are all scored as correct, such as typing the correct sequence of keyboard commands or selecting the appropriate commands from a menu (e.g., File → Print, etc.; Haber & Stoddart, n.d.). Similarly, the sequence of actions affects scoring in the iSkills assessment. For example, in a Web search task, examinees receive more credit for using sophisticated search strategies (i.e., joining two keywords with AND) on their first search attempt and less credit if they discover and deploy this strategy only after having previously submitted several rounds of less sophisticated search queries (Katz et al., 2004). While it is true that these performances might not be as open ended as real-world tasks, they may be sufficiently rich so that they provide measurement beyond that provided by traditional testing formats.

Score Reporting Considerations

"Score reports are where the rubber hits the road in the validity argument for an assessment" (Zapata-Rivera & Katz, 2014, p. 442). Assessment results drive academic decisions about institutions or individuals, and so the nature of the information reported from an assessment strongly determines that assessment's utility for a particular institutional purpose. When selecting an assessment, institutions should consider not only the characteristics of the assessment itself — the target construct, the testing format, the test length — but also the nature of the information provided about student performance. The nature and type of score reports available vary across DIL assessments, with some tests only providing information to institutions about aggregate groups of students, whereas others provide individual-level score reports with personalized feedback and subscores. Institutional-level information might inform the overall performance of groups of students (e.g., particular majors or grade levels) and might be used to determine whether an institution has achieved its accreditation

goals for DIL SLOs. Individual-level information might help students determine whether further coursework or other instruction is needed.

Ideally, a DIL assessment would provide useful information at both the institutional level and individual levels. In either case, score providers should ensure the quality of the information provided in score reports. For example, when providing subscores, one should ensure that these subscores are both reliable and distinct from each other (Sinharay & Haberman, 2008). If the subscores are highly correlated, even if they are reliable, it may make less sense to report them as the subscores may not provide information beyond what is provided in the total scores. Further, we recommend that at the individual level, institutions seek reports that include performance feedback: descriptive, qualitative information about students' performance on DIL tasks, rather than atomistic, quantitative information, to help score users better understand students' strengths and weaknesses for improvement purposes.

Conclusions

DIL is an increasingly important set of skills in today's environment of ever-changing access to and interactions with technology, particularly in light of the centrality of technology for contributing to the emerging global information economy. Because DIL skills are important for professional and academic success, higher education institutions should consider the extent to which their students possess these skills yet also recognize that the construct of DIL reflects the coordination of cognitive skills, thereby extending beyond the ability to use specific technologies for their own sake. The evidence presented in this report reveals considerable continuity among definitions of DIL, as representing a set of integrated information processing skills that are distinguishable from measures of general academic ability (e.g., general literacy skills). Thus, DIL is a distinct construct that can be assessed in a variety of ways. The current review presents a number of available assessment options that higher education institutions may use to obtain evidence of this construct, including self-report, selected-response and performance-based measures, although those assessments demonstrate varying degrees of reliability and validity evidence, as shown here. We suggest that a performance-based assessment of DIL that presents information problems in a wide range of personal, workplace, and academic contexts and aligns to widely accepted aspects of the construct appears to be a particularly useful option for meeting the needs of higher education institutions. We hope that this paper serves as a resource to this community in selecting among existing DIL assessments or in designing new approaches to DIL measurement.

Notes

1 The European Computer Driving Licence (ECDL) was initially launched in Europe in 1996. Three years later the assessment was offered internationally and is known as the International Computer Driving Licence (ICDL) outside of Europe (ECDL Foundation, 2015a). We use ECDL throughout the paper.

2 Note that accessing, selecting, and evaluating sources are not strictly related to contexts of digital information use (i.e., students must deploy these skills when selecting among available print resources in libraries). As SAILS includes questions that measure information skills in both print and digital contexts, it is not clear from these data whether the reported improvements are due specifically to the development of DIL skills, or more general competency with library research methods.

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